

~~Claims~~

1 1. In a metal treating apparatus having a pot for holding a bath of molten  
2 metal, transfer means for moving the molten metal in the pot, including a molten metal-  
3 lifting passage having inlet opening means disposed in the molten metal for receiving  
4 molten metal into the metal-lifting passage, the metal-lifting passage having an outlet  
5 opening in the molten metal for discharging molten metal received in the inlet opening  
6 means, the metal-lifting passage having gas-injection openings upstream of the molten  
7 metal outlet opening; gas passage means for connecting a source of gas to the gas-  
8 injection openings in the form of a gas jet into the metal-lifting passage such that the  
9 gas induces a flow of molten metal from the molten metal inlet opening means toward  
10 the molten metal outlet opening, the improvement comprising:

11 the molten metal inlet opening means comprising a window in the  
12 metal-lifting passage disposed coaxially and/or laterally with respect to the path of  
13 motion of the gas flowing through the metal-lifting passage.

1 2. The improvement as defined in Claim 1, in which the inlet opening means  
2 comprises a plurality of windows disposed in an annular array around the path of  
3 motion of gas moving from the gas injection <sup>openings</sup> opening.

1 3. The improvement as defined in Claim 2, in which the gas induces the  
2 molten metal to move along an axis of motion from the inlet opening means towards the  
3 outlet opening, and the gas-injection openings are disposed to introduce a gas jet into  
4 the metal-lifting passage along said axis of motion.

1 3. The improvement as defined in Claim 1, in which said transfer means  
2 includes a tubular element for passing the gas to the gas-injection openings.

1 4. The improvement as defined in Claim 1, including a convergent/divergent  
2 nozzle in the metal-lifting passage downstream of the inlet opening means.

1 5. The improvement as defined in Claim 4, in which the metal-lifting passage  
2 has a linear upright inlet section, that connects very gradually through a large radii with  
a generally horizontal outlet section terminating with said outlet opening.

1 6. The improvement as defined in Claim 1, in which the metal-lifting  
2 passage has an elliptical cross section.

1 7. The improvement as defined in Claim 1, in which the gas is injected in a  
2 direction along the longitudinal axis of the metal-lifting passage.

1 8. The improvement as defined in Claim 1, in which the metal-lifting passage  
2 has inlet opening means disposed vertically below the outlet opening.

1 10. The improvement as defined in Claim 1, in which the gas is introduced as  
2 a jet such that the momentum of the gas pushes the metal along the metal passage.

1 9 11. The improvement as defined in Claim 1, in which the metal-lifting passage

2 has an enlarged inlet end connected by a convergent nozzle to an outlet section having

3 a smaller diameter than the inlet end.

1 12. A method for raising molten metal in a bath of molten metal comprising  
2 the steps of:

3 disposing a body having an internal molten metal-lifting passage, an inlet  
4 opening connected to the internal metal-lifting passage, in the molten metal for  
5 receiving metal into the metal-lifting passage;

introducing a gas at a lower position in the gas-lifting passage; and then

introducing molten metal through a coaxially and/or laterally spaced  
window into the metal-lifting passage such that the gas rises to move discrete elements  
of the molten metal up the metal-lifting passage.

13. In a metal treating apparatus having a pot for holding a bath of molten  
metal, transfer means for moving the molten metal in the pot, including a molten metal-

moving passage having inlet opening means disposed in the molten metal for receiving

molten metal into the metal-moving passage, the metal-moving passage having an

outlet opening for discharging molten metal received in the inlet opening means, the

metal-moving passage having gas-injection openings upstream of the molten metal

outlet opening; gas passage means for connecting a source of gas to the gas-injection

openings in the form of a gas jet into the metal-moving passage such that the gas

induces a flow of molten metal from the molten metal inlet opening means toward the

molten metal outlet opening.

1 <sup>11</sup>14. A metal treating apparatus as defined in Claim <sup>10</sup>13, in which the metal-  
2 moving passage is substantially horizontal and elongated, and the inlet-opening means  
3 is at one end of the metal-moving passage and the outlet opening is at the opposite end  
4 of the metal-moving passage.

1 <sup>12</sup>15. An apparatus as defined in Claim <sup>10</sup>13, including a window in the metal-  
2 moving passage disposed laterally with respect to the path of motion of the gas moving  
3 through the metal-moving passage.

1 <sup>13</sup>16. An apparatus as defined in Claim <sup>10</sup>13, in which the metal inlet opening  
2 means comprises an opening disposed coaxially with respect to the path of motion of  
3 the gas moving through the metal-moving passage.

1 <sup>14</sup>17. An apparatus as defined in Claim <sup>10</sup>13, in which the metal-moving passage  
2 has a divergent section between the inlet opening means and the outlet opening.

1 <sup>15</sup>18. An apparatus as defined in Claim <sup>10</sup>13, in which the outlet opening has a  
2 horizontally elongated elliptical cross section.

1 <sup>16</sup>19. An apparatus as defined in Claim <sup>10</sup>13, in which the inlet opening means  
2 comprises a manifold having a plurality of gas injection nozzles.

1        20.     An apparatus as defined in Claim <sup>16</sup>19, in which the manifold has a plurality  
2     of legs disposed in the path of motion of the metal being received into the metal-moving  
3     passage, and the nozzle means are disposed in said legs to deliver the gas axially with  
4     respect to the metal-moving passage.

1        21.     A pump for moving a liquid comprising:  
2                a body having a liquid inlet port for receiving liquid from a liquid  
3     source, and a liquid outlet port, and an internal liquid passage fluidly connecting the  
4     liquid inlet port and the liquid outlet port for passing liquid therethrough;  
                 the internal passage having a tapered passage including one end  
                 thereof defining said inlet port of a first diameter, and an opposite end defining an outlet  
                 port of a second greater diameter downstream of the inlet port; and  
                 a source of a gas, and gas jet means disposed in the tapered <sup>passage</sup> ~~well~~  
to induce a flow of the liquid from the inlet port toward the outlet port.

1        22.     A pump as defined in claim <sup>19</sup>21, in which the gas is delivered at an acute  
2     angle with respect to the flow of the liquid.

1        23.     A pump as defined in claim <sup>18</sup>21, in which the gas is introduced axially in the  
2     direction of gas flow, adjacent the inlet port to induce liquid flow through the inlet port  
3     toward the outlet port.

1        24.     A pump as defined in claim <sup>18</sup>21, in which the internal passage has a  
2     cylindrical cross-section.

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1 <sup>22</sup> 28. A pump as defined in claim <sup>18</sup> 21, in which the gas <sup>jet means</sup> ports are below the outlet  
2 opening.

1 <sup>23</sup> 28. A pump as defined in claim <sup>18</sup> 21, in which the liquid flows through the outlet  
2 opening along a generally vertical path of motion.

1 <sup>27</sup> Apparatus for introducing a gas into a moving liquid comprising:  
2 a body having a liquid inlet port for receiving liquid from a liquid  
3 source, and a liquid outlet port, and an internal liquid passage fluidly connecting the  
4 liquid inlet port and the liquid outlet port for passing liquid therethrough;  
5 the internal passage having a tapered passage including one end  
6 thereof defining said inlet port of a first diameter, and an opposite end defining an outlet  
7 port of a second lesser diameter downstream of the inlet port; and  
8 a source of a gas, and gas jet means disposed in the internal  
9 passage adjacent the inlet port to induce flow of the liquid from the inlet port toward the  
10 outlet port.

1 <sup>28</sup> Apparatus for introducing a gas into a moving liquid stream comprising:  
2 a body means having a tapered internal passage, and an  
3 inlet and an outlet for passing a liquid through the tapered internal passage;  
4 a gas distribution means disposed in the body adjacent the  
5 tapered passage, the gas distribution means having conduit means connected to a

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6 source of a gas, and nozzle means disposed in the body for delivering the gas into the  
7 liquid to induce a flow of the liquid through said internal tapered passage.

1 <sup>25</sup>29. Apparatus as defined in claim <sup>25</sup>28, in which the nozzle means are disposed  
2 in an annular array around the path of the moving liquid.

1 <sup>15</sup>30. Apparatus as defined in claim <sup>15</sup>28, in which the body means has a tapered  
2 inlet passage upstream of the gas distribution means.

1 <sup>25</sup>31. Apparatus as defined in claim <sup>25</sup>28, in which the body means has a tapered  
outlet passage downstream of the gas distribution means.

1 <sup>25</sup>32. Apparatus as defined in claim <sup>25</sup>28, in which the body means has an internal  
passage having an inlet passage which converges toward the annular gas distribution  
means, and an outlet passage which diverges from the gas distribution means.

1 <sup>25</sup>33. Apparatus as defined in claim <sup>25</sup>28, in which the internal passage is adapted  
2 to pass a liquid along a flow path along an axis of motion, and the gas distribution  
3 means includes nozzles disposed in an annular array around said fluid flow and  
4 disposed to deliver the gas at an angle  $\alpha$  with respect to said axis of motion.

1 <sup>20</sup>34. Apparatus as defined in claim <sup>20</sup>33, in which  $\alpha$  the angle between and the  
2 direction of gas flow and the direction of fluid flow is in accordance with the following  
3 relationship:  $0^\circ \leq \alpha < 30^\circ$ .

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1 35. Apparatus as defined in claim 28, in which the body means has a  
2 divergent passage immediately downstream of the gas distribution means, the divergent  
3 passage having a frusto-conical wall formed with an angle  $\alpha$  with respect to the  
4 direction of gas flow in accordance with the following relationship:  $0^\circ \leq \alpha < 30^\circ$ .

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1 An apparatus as defined in claim 28, in which the apparatus is disposed to  
2 pass the fluid in a generally horizontal direction, and including an outlet duct connected  
3 downstream of the tapered passage, and the outlet duct has a generally S-shaped  
configuration so as to pass the gas from the pump upwardly and then in a generally  
horizontal direction.

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